

# **UNIT 3: CHEMICAL PROPERTIES**



# LEARNING OBJECTIVES

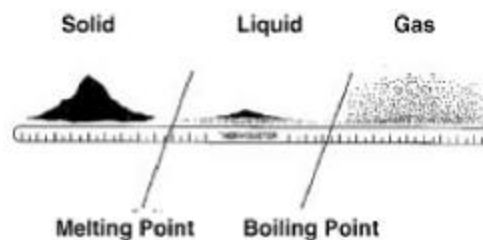
By the end of this section, participants will be able to:

- Recognize the three states of matter
- Define the following terms:
  - Vapor pressure
  - Flash point
  - Lower and upper explosive limits
  - Specific gravity
  - Solubility
  - Vapor density
  - Chemical reactivity
  - Ignition temperature
  - pH
- Describe how the pH scale can be used to assess the hazards of acids and bases
- Describe the following types of chemical reactions:
  - Oxidation
  - Explosion
  - Gas Compression
  - BLEVE



# STATES OF MATTER

All elements exist in nature in one of three states: **solid**, **liquid**, or **gas**. Substances can change from one state to another as changes occur in temperature or pressure, or both. A change in a material's state is likely to affect the degree of hazard posed by the material, as well as the tactics for controlling the situation. For example, a toxic substance may be more hazardous in the gaseous state than in the liquid state because it is easier to inhale as a gas and more difficult to control.



## Solids

A solid is a substance that retains a definite size and shape under normal conditions. When most solids melt, they change to liquid. The temperature at which this occurs is called the **melting point**. When solids change directly to gas, the process is called **sublimation**. Carbon dioxide (dry ice) is a well-known example of a solid that sublimates.

## Liquids

Liquids are substances that flow easily and have a specific volume but no specific shape. The temperature at which a liquid freezes is called the **freezing point**. The temperature at which a liquid changes to a gas is its **boiling point**. At this temperature, which is unique to each liquid, bubbles of the liquid rise to the surface and enter the surrounding air. The boiling point of a liquid is related to its vapor pressure.

## Gases

A gas is a substance that expands or compresses readily and has no independent shape or volume. Gases may condense to form liquids; this change occurs when a gas is cooled to or below its boiling point. Substances that occur naturally as gases have low boiling points compared to solids and liquids.

To evaluate the hazard posed by a gas, you must know (or estimate) its concentration in air. Explosive limits are one way to evaluate the concentration of flammable gases and vapors. Concentration of gas can also be expressed in terms of percent, parts per million (ppm), and parts per billion (ppb). These terms are typically used in reference materials when listing the concentration of a gas or vapor that causes health effects. One part per million is equal to 1/1,000,000.

### IDLH

(Immediately Dangerous to Life and Health) is a reference frequently mentioned in resource material. IDLH is the maximum level of exposure, without irreparable effects, within 30 minutes.

# CHEMICAL PROPERTIES

## Vapor Pressure

Vapor pressure is a measure of the ability to evaporate, that is, to change from a liquid to a gas. (A liquid in the gas state is a vapor.) Vapor pressure is often measured in millimeters (mm) of mercury (Hg), but other units may be used. The higher the vapor pressure, the more likely a liquid is to evaporate. For example:

| Material  | Approximate Vapor Pressure at Room Temperature |
|-----------|------------------------------------------------|
| Rock      | 0 mm Hg                                        |
| Water     | 25 mm Hg                                       |
| Acetone   | 250 mm Hg                                      |
| Any gas   | >760 mm Hg                                     |
| Acetylene | 2,500 mm Hg                                    |

As temperature increases, the vapor pressure of a liquid increases. For example, look at the effect of temperature on the vapor pressure of water on the following chart.

| Vapor Pressure of Water | Temperature of Water |
|-------------------------|----------------------|
| 25 mm Hg                | 72° F                |
| 93 mm Hg                | 122° F               |
| 760 mm Hg               | 212° F               |

If the temperature is high enough, the vapor pressure rises until it equals atmospheric pressure. At this point, the liquid boils and becomes vapor. Because liquids expand when they vaporize, the effect of temperature on a liquid's vapor pressure can be catastrophic if the liquid is in a closed vessel. If there is no mechanism for venting, the vapors generated as the liquid is heated will exert increasing amounts of pressure on the vessel, possibly leading to container failure.

## Flash Point

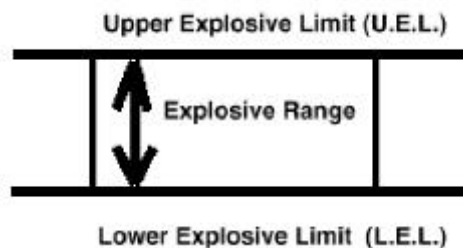
Flammable liquids with high vapor pressures are generally more dangerous than those with low vapor pressures. This is because they more readily form ignitable mixtures in air and are more easily inhaled. **Flash point** is the temperature at which a liquid generates enough vapors to create an ignitable mixture near the surface of the liquid.

A **flammable liquid** is a liquid that has a flash point below 100°F (38°C). Liquids that have flash points of 100°F or more are classified as **combustible liquids**.

## Explosive Limit

**Explosive** or **flammable limit** refers to the concentration of a flammable vapor or gas in air. Below the lower explosive limit (LEL), the mixture is “too lean” to ignite. This means that there are not enough flammable vapors in the air. Above the upper explosive limit (UEL), the mixture is “too rich” to ignite. That is, there is too little oxygen to support combustion. Between the LEL and UEL, the mixture is explosive or flammable. Remember that sources of electricity such as lights, motors, traffic, and static electricity can ignite mixtures between the LEL and UEL.

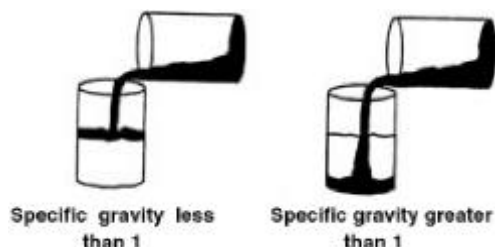
Flammable gases have an LEL of less than 13%, or a flammable range greater than 12%. Most flammable gases have LEL ranges of 3% to 6%.





## Specific Gravity

**Specific gravity** is a concept used to measure the weight of solids and liquids in comparison to an equal volume of water. Water has a specific gravity of one. Solids and liquids that are heavier than an equal volume of water have specific gravities greater than one. Similarly, solids and liquids that are lighter than water have specific gravities less than one.



Specific gravity has no unit of measure. It is only a relative value (relative to water). The specific gravity of a substance indicates whether it will sink or float in water. This property can also determine your response activity (for example, the type of dam you build to control a liquid spill in water).

## Solubility

**Solubility** refers to the degree that one substance mixes with another substance. The mixture is called a **solution**. The substance presenting greater amount is called the **solvent**. Water can be a solvent, though in common usage the term refers to petroleum-based chemicals. The substance present in lesser amount is called the **solute**. A solute may be a gas, a liquid, or a solid.

If a solute mixes completely in a solvent, it is said to be **miscible** with that solvent. For example, alcohols such as methyl, ethyl, and propyl alcohol are miscible with water. **Water miscible** means that the liquid is infinitely soluble in water. Regardless of the amount of methyl alcohol added to water, it will all mix. All other liquids (and all solids) are either very soluble, soluble, sparingly soluble, or insoluble. Some references may also list solubility data in terms of a percentage, indicating the weight of the material that will dissolve in a certain amount of water.

## Vapor Density

The concept of **vapor density** is used to measure the weight of a gas compared to an equal volume of air. Air has a vapor density of one. Substances with vapor densities less than one are lighter than an equal volume of air and will rise in air. Those with vapor densities greater than one will sink in air, and often collect in low lying areas or close to the ground. This is important when sampling the air, identifying safe areas during an emergency, and predicting how a gas will spread.

There are a couple of shortcuts in determining whether a gas or vapor has a vapor density less than air. One method is to use the **molecular weight** of the chemical. The molecular weight is the mass that is assigned to atoms or molecules that make up a chemical. This unit may be found in references such as the NIOSH Pocket Guide to Chemical Hazards. Vapors and gases with molecular weights greater than 29 (the molecular weight of air) tend to sink in air. Vapors of flammable liquids also tend to sink in air. (Flammable gases may rise or sink, depending on the gas; for example, propane sinks, and methane rises.)

# Chemical Reactivity

Chemical reactions result when two or more substances combine to form new chemicals and energy is absorbed or released. Polymerization, combustion, and ionization are examples of chemical reactions. The rate at which a chemical reaction occurs depends on a number of factors, including:

- **Temperature**—increasing temperature usually speeds reactions
- **Concentration**—increasing the concentrations of the reacting materials usually increases the rate of reaction
- **Pressure**—increasing pressure, especially on reacting gases and vapors, may speed reactions, though this is not always true
- **Presence of catalysts**—a catalyst is a substance that increases the rate of chemical reactions, but is not changed by the reaction

In addition to the factors listed above, the physical and chemical properties of the reactive materials can influence the reaction. For example, gases and vapors react more readily than liquids and solids; and highly reactive materials can spontaneously explode or ignite when exposed to another substance. Some materials react when exposed to water. For example, sodium metal is extremely **water-reactive** and may explode when in contact with water. It is stored dry or in mineral oil or kerosene. **Air reactive** materials react when exposed to air. White and yellow phosphorous spontaneously ignite in air; a related term, pyrophoric, is used to describe a material (liquid or solid) that spontaneously ignites in air at or below 130°F.

## Ignition Temperature

References may list the **ignition temperature** of a chemical (also called the auto-ignition temperature). This is the temperature at which a material starts to burn without a flame or other ignition source present. At this temperature, gases or vapors are consumed in fire as rapidly as they are formed, and the material continues self-sustained combustion. Many flammable solids have ignition temperatures greater than 400°F, much higher than flash points of flammable liquids. One notable exception is phosphorus (white or yellow), with an ignition temperature of 86°F.

# pH

The pH scale is a reference scale indicating the acidity or alkalinity of materials. The scale ranges from 0 to 14, with 7 considered neutral. Values lower than 7 indicate increasing acidity, while those higher than 7 indicate increasing alkalinity. The pH scale is a logarithmic scale, with 7 at the center of the scale. This means that the difference in acidity from pH 6 to pH 7 is small, while the difference from pH 3 to pH 4 is greater, and the difference in acidity between pH 1 and pH 2 is very great. When dealing with acids and bases, it is also important to obtain information about the **concentration** of the acid or base. Concentration indicates the percentage of the material in water. Both acids and alkalis can cause injury. Materials with a very low or very high pH are the most hazardous, and any highly concentrated acids or bases should be carefully assessed before action is taken. Caustics are particularly dangerous because the chemical seeks out the acids in the body.

## Other Chemical Reactions

Other chemical reactions may affect the way you respond to an incident involving a hazardous material.

### Oxidation

Oxidation is a chemical reaction that enables a substance to burn. In a fire, the presence of an oxidizer will make the fire burn hotter and faster, and may cause explosions. Oxygen is a powerful oxidizer, but by itself it is non-flammable. When added to other materials (even non-flammable protective clothing) it dramatically accelerates combustion.

### Explosions

Explosions are chemical reactions that suddenly release a tremendous amount of energy. Explosions can be loosely categorized according to reaction time. High explosives react quickly — within millionths of a second — while low explosives react more slowly. High explosives (such as dynamite) **detonate**; that is, they create and almost instantaneously release gas. Low explosives (such as black powder) **deflagrate** in that they create gas a little more slowly.

## Gas Compression

Gas compression can also lead to chemical reactions. Compared with other states of matter, gases are the least dense. They can be compressed by increasing pressure or decreasing temperature to force the gas into a smaller volume. Certain gases are classified as cryogenic because of their low temperatures and extremely low boiling points.

Unlike other compressed gases, you must consider the extreme coldness of a cryogenic gas during a fire. Cryogenic containers always carry safety relief devices. Applying water may freeze these devices and cause the container to rupture.

A hazard common to all compressed gases is the potential for the expansion of the gas when it is warmed or no longer under pressure. Containers may fail, releasing large amounts of the gas. The expansion ratio refers to the comparison of a volume of the gas to its liquefied form. For example, liquefied natural gas (LNG) has an expansion ratio of 600 to 1. This means that one cubic foot of LNG will expand to 600 cubic feet when warmed or no longer under pressure.

## BLEVE

Flammable gases that are transported or stored in their liquefied form are particularly hazardous because there is the potential for a **boiling liquid expanding vapor explosion (BLEVE)**. This is the term for an uncontrolled fire and explosion of vapor as it escapes from a ruptured container of liquefied flammable gas. A BLEVE occurs when a container is exposed to fire. The liquid inside begins to boil and vaporize. The vapor is vented from the relief valve and the level of liquid begins to drop. As this happens, the flames impinge on the vapor space of the tank. Heat and pressure build, and the container weakens and ruptures, resulting in an explosion.



# **UNIT 3**

## **APPENDIX**





## MSDS Exercise

Material Safety Data Sheets (MSDSs) contain standard information about hazardous chemicals at fixed locations. They are published by chemical manufacturers. The format of an MSDS, including the order in which information appears, may be different for each chemical. It may also vary among manufacturers of the same chemical. Review the three MSDSs on the following pages for methyl ethyl ketone, carbon disulfide, and muriatic acid. Then answer the questions below.

Which of these chemicals is/are flammable?

Which is/are required to have a Flammable Liquid and Poison label?

Which will evaporate the fastest at room temperature?

Which is the most toxic?

---

1 - PRODUCT IDENTIFICATION

---

PRODUCT NAME: METHYL ETHYL KETONE  
FORMULA: CH<sub>3</sub>COCH<sub>2</sub>CH<sub>3</sub>  
FORMULA WT: 72.11  
CASE NO.: 78-93-3  
NIOSH/RTECS NO.: EL6475000  
COMMON SYNONYMS: 2-BUTANONE; MEK; ETHYL METHYL KETONE; METHYLACETONE  
PRODUCT CODES: 9214,9323,9211,5385,9319,Q531  
EFFECTIVE: 08/27/86  
REVISION #02

PRECAUTIONARY LABELING  
BAKER SAF-T-DATA(TM) SYSTEM

HEALTH - 2 MODERATE  
FLAMMABILITY - 3 SEVERE (FLAMMABLE)  
REACTIVITY - 2 MODERATE  
CONTACT - 1 SLIGHT

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

LABORATORY PROTECTIVE EQUIPMENT

SAFETY GLASSES; LAB COAT; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER

PRECAUTIONARY LABEL STATEMENTS

WARNING  
EXTREMELY FLAMMABLE  
CAUSES IRRITATION  
HARMFUL IF INHALED  
KEEP AWAY FROM HEAT, SPARKS, FLAME.  
AVOID BREATHING VAPOR. KEEP IN TIGHTLY CLOSED CONTAINER. USE WITH  
ADEQUATE VENTILATION. WASH THOROUGHLY AFTER HANDLING. IN CASE OF FIRE,  
USE ALCOHOL FOAM, DRY CHEMICAL, CARBON DIOXIDE - WATER MAY BE INEFFECTIVE.  
FLUSH SPILL AREA WITH WATER SPRAY.

SAF-T-DATA(TM) STORAGE COLOR CODE: RED (FLAMMABLE)

---

2 - HAZARDOUS COMPONENTS

---

| COMPONENT           | %      | CASE NO. |
|---------------------|--------|----------|
| METHYL ETHYL KETONE | 90-100 | 78-93-3  |

---

3 - PHYSICAL DATA

---

BOILING POINT: 80 C ( 176 F) VAPOR PRESSURE(MM HG): 78

|                    |                                                 |                       |     |
|--------------------|-------------------------------------------------|-----------------------|-----|
| MELTING POINT:     | -87 C ( -125 F)                                 | VAPOR DENSITY(AIR=1): | 2.5 |
| SPECIFIC GRAVITY:  | 0.81                                            | EVAPORATION RATE:     | 5.7 |
| (H2O=1)            |                                                 | (BUTYL ACETATE=1)     |     |
| SOLUBILITY(H2O):   | APPRECIABLE (MORE THAN 10 %)                    | % VOLATILE BY VOLUME: | 100 |
| APPEARANCE & ODOR: | CLEAR COLORLESS, LIQUID WITH ACETONE-LIKE ODOR. |                       |     |

---

**4 - FIRE AND EXPLOSION HAZARD DATA**

---

FLASH POINT (CLOSED CUP -7 C ( 20 F)      NFPA 704M RATING: 1-3-0

FLAMMABLE LIMITS: UPPER - 11.4 %      LOWER - 1.8 %

**FIRE EXTINGUISHING MEDIA**

USE ALCOHOL FOAM, DRY CHEMICAL OR CARBON DIOXIDE. (WATER MAY BE INEFFECTIVE.)

**SPECIAL FIRE-FIGHTING PROCEDURES**

FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE. MOVE CONTAINERS FROM FIRE AREA IF IT CAN BE DONE WITHOUT RISK. USE WATER TO KEEP FIRE-EXPOSED CONTAINERS COOL.

**UNUSUAL FIRE & EXPLOSION HAZARDS**

VAPORS MAY FLOW ALONG SURFACES TO DISTANT IGNITION SOURCES AND FLASH BACK. CLOSED CONTAINERS EXPOSED TO HEAT MAY EXPLODE. CONTACT WITH STRONG OXIDIZERS MAY CAUSE FIRE.

**TOXIC GASES PRODUCED**

CARBON MONOXIDE, CARBON DIOXIDE

---

**5 - HEALTH HAZARD DATA**

---

THRESHOLD LIMIT VALUE (TLV/TWA): 590 MG/M3 ( 200 PPM)

SHORT-TERM EXPOSURE LIMIT (STEL): 885 MG/M3 ( 300 PPM)

PERMISSIBLE EXPOSURE LIMIT (PEL): 590 MG/M3 ( 200 PPM)

|                                    |      |
|------------------------------------|------|
| TOXICITY: LD50 (ORAL-RAT)(MG/KG) - | 2737 |
| LD50 (IPR-MOUSE)(MG/KG) -          | 616  |
| LD50 (SKN-RABBIT) (G/KG) -         | 13   |

CARCINOGENICITY: NTP: NO      IARC: NO      Z LIST: NO      OSHA REG: NO

**EFFECTS OF OVEREXPOSURE**

INHALATION OF VAPORS MAY CAUSE HEADACHE, NAUSEA, VOMITING, DIZZINESS, DROWSINESS, IRRITATION OF RESPIRATORY TRACT, AND LOSS OF CONSCIOUSNESS. CONTACT WITH SKIN OR EYES MAY CAUSE IRRITATION. PROLONGED EXPOSURE MAY CAUSE DERMATITIS. LIQUID MAY CAUSE PERMANENT EYE DAMAGE. INGESTION MAY CAUSE NAUSEA, VOMITING, HEADACHES, DIZZINESS, GASTROINTESTINAL IRRITATION.

**TARGET ORGANS**

NASAL SEPTUM, LUNGS

**MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE**

NONE IDENTIFIED

**ROUTES OF ENTRY**

INHALATION, INGESTION, EYE CONTACT, SKIN CONTACT

**EMERGENCY AND FIRST AID PROCEDURES**

CALL A PHYSICIAN.

IF SWALLOWED, DO NOT INDUCE VOMITING.

IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. FLUSH SKIN WITH WATER.

---

**6 - REACTIVITY DATA**

---

STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: HEAT, FLAME, OTHER SOURCES OF IGNITION

INCOMPATIBLES: STRONG OXIDIZING AGENTS, STRONG BASES, CAUSTICS, MINERAL ACIDS, AMINES AND AMMONIA, HALOGENS

DECOMPOSITION PRODUCTS: CARBON MONOXIDE, CARBON DIOXIDE

---

**7 - SPILL AND DISPOSAL PROCEDURES**

---

**STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE**

WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING. SHUT OFF IGNITION SOURCES; NO FLARES, SMOKING OR FLAMES IN AREA. STOP LEAK IF YOU CAN DO SO WITHOUT RISK. USE WATER SPRAY TO REDUCE VAPORS. TAKE UP WITH SAND OR OTHER NON-COMBUSTIBLE ABSORBENT MATERIAL AND PLACE INTO CONTAINER FOR LATER DISPOSAL. FLUSH AREA WITH WATER.

J. T. BAKER SOLUSORB(R) SOLVENT ADSORBENT IS RECOMMENDED FOR SPILLS OF THIS PRODUCT.

**DISPOSAL PROCEDURE**

DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

EPA HAZARDOUS WASTE NUMBER: U159 (TOXIC WASTE)

---

**8 - PROTECTIVE EQUIPMENT**

---

VENTILATION: USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TLV REQUIREMENTS.

RESPIRATORY PROTECTION: RESPIRATORY PROTECTION REQUIRED IF AIRBORNE CONCENTRATION EXCEEDS TLV. AT CONCENTRATIONS UP TO 1000 PPM, A CHEMICAL CARTRIDGE RESPIRATOR WITH ORGANIC VAPOR CARTRIDGE IS RECOMMENDED. ABOVE THIS LEVEL, A SELF-CONTAINED BREATHING APPARATUS IS RECOMMENDED.

EYE/SKIN PROTECTION: SAFETY GOGGLES, UNIFORM, APRON, RUBBER GLOVES ARE RECOMMENDED.

---

**9 - STORAGE AND HANDLING PRECAUTIONS**

---

SAF-T-DATA(TM) STORAGE COLOR CODE: RED (FLAMMABLE)

**SPECIAL PRECAUTIONS**

BOND AND GROUND CONTAINERS WHEN TRANSFERRING LIQUID. KEEP CONTAINER TIGHTLY CLOSED. STORE IN A COOL, DRY, WELL-VENTILATED, FLAMMABLE LIQUID STORAGE AREA.

---

**10 - TRANSPORTATION DATA AND ADDITIONAL INFORMATION**

---

**DOMESTIC (D.O.T.)**

|                      |                     |
|----------------------|---------------------|
| PROPER SHIPPING NAME | METHYL ETHYL KETONE |
| HAZARD CLASS         | FLAMMABLE LIQUID    |
| UN/NA                | UN1193              |
| LABELS               | FLAMMABLE LIQUID    |
| REPORTABLE QUANTITY  | 5000 LBS.           |

**INTERNATIONAL (I.M.O.)**

|                      |                     |
|----------------------|---------------------|
| PROPER SHIPPING NAME | METHYL ETHYL KETONE |
| HAZARD CLASS         | 3.2                 |
| UN/NA                | UN1193              |
| LABELS               | FLAMMABLE LIQUID    |

MATERIAL SAFETY DATA SHEET

FSC: 6810

NIIN: 012090692

Manufacturer's CAGE: 62910

Part No. Indicator: A

Part Number/Trade Name: CARBON DISULFIDE,4351-030

General Information

Item Name: CARBON DISULFIDE, ANALYZED REAGENT

Company's Name: MALLINCKRODT INC., SCIENCE PRODUCTS DIVISION

Company's Street: PARIS BYPASS

Company's P. O. Box: M

Company's City: PARIS

Company's State: KY

Company's Country: US

Company's Zip Code: 40361

Company's Emerg Ph #: 314-982-5000

Company's Info Ph #: 800-354-2050

Record No. For Safety Entry: 001

Tot Safety Entries This Stk#: 001

Status: SE

Date MSDS Prepared: 06APR89

Safety Data Review Date: 08FEB95

Supply Item Manager: KX

MSDS Preparer's Name: UNKNOWN

MSDS Serial Number: BGQQG

Specification Number: NONE

Spec Type, Grade, Class: NONE

Hazard Characteristic Code: F5

Unit Of Issue: BT

Unit Of Issue Container Qty: 1 PT

Type Of Container: BOTTLE

Net Unit Weight: 1.3 LBS

NRC/State License Number: NOT RELEVANT

Ingredients/Identity Information

Proprietary: NO

Ingredient: CARBON DISULFIDE (SARA 302/313) (CERCLA)

Ingredient Sequence Number: 01

Percent: 100

NIOSH (RTECS) Number: FF6650000

CAS Number: 75-15-0

OSHA PEL: 20 PPM

ACGIH TLV: S, 10 PPM; 9495

Other Recommended Limit: NOT RECOMMENDED

Physical/Chemical Characteristics

Appearance And Odor: CLEAR COLORLESS LIQUID, ODORLESS (PURE)/STRONG

GARLIC-LIKE ODOR

Boiling Point: 115F,46C

Melting Point: -148F,-100C

Vapor Pressure (MM Hg/70 F): 300 @ 68F

Vapor Density (Air=1): 2.6

Specific Gravity: 1.26  
Decomposition Temperature: UNKNOWN  
Evaporation Rate And Ref: 22.6 (N-BUTYL ACETATE=1)  
Solubility In Water: 0.2 %  
Percent Volatiles By Volume: 100  
Viscosity: UNKNOWN  
Corrosion Rate (IPY): UNKNOWN  
Autoignition Temperature: 194F

---

#### Fire and Explosion Hazard Data

---

Flash Point: -22F, -30C  
Lower Explosive Limit: 1.3  
Upper Explosive Limit: 50  
Extinguishing Media: USE CARBON DIOXIDE, SAND, FOAM/DRY CHEMICAL. WATER SPRAY MAY BE USED TO KEEP FIRE EXPOSED CONTAINERS COOL.  
Special Fire Fighting Proc: WEAR FULL PROTECTIVE CLOTHING AND NIOSH-APPROVED SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN THE POSITIVE PRESSURE MODE.  
Unusual Fire And Expl Hazards: VAPOR IS HEAVIER THAN AIR AND CAN TRAVEL CONSIDERABLE DISTANCE TO A SOURCE OF IGNITION AND FLASH BACK. CONTAINERS MAY RUPTURE DUE TO VAPOR PRESSURE BUILDUP.

---

#### Reactivity Data

---

Stability: YES  
Cond To Avoid (Stability): HEAT, IGNITION SOURCES, SPARKS, STATIC ELECTRICITY, HOT SURFACES, LIGHT  
Materials To Avoid: STRONG OXIDIZING AGENTS, CHEMICALLY ACTIVE METALS (POTASSIUM, ZINC), AZIDES, ORGANIC AMINES  
Hazardous Decomp Products: CARBON MONOXIDE, CARBON DIOXIDE, OXIDES OF SULFUR  
Hazardous Poly Occur: NO  
Conditions To Avoid (Poly): NOT RELEVANT

---

#### Health Hazard Data

---

LD50-LC50 Mixture: TLV 10 PPM (SKIN)  
Route Of Entry - Inhalation: YES  
Route Of Entry - Skin: YES  
Route Of Entry - Ingestion: YES  
Health Haz Acute And Chronic: TARGET ORGANS: EYES, SKIN, CNS, LIVER, KIDNEYS, RESPIRATORY & GI TRACTS. ACUTE- TOXIC. MAY BE FATAL IF SWALLOWED OR INHALED. HARMFUL IF ABSORBED THROUGH SKIN. REPRODUCTIVE HAZARD. A POTENTIAL NEUROTOXIN. EYE CONTACT MAY CAUSE SEVERE PAIN. INHALATION CAUSES CNS DEPRESSION. CHRONIC- LIVER, RENAL & REPRODUCTIVE DISORDERS.  
CARCINOGENICITY - NTP: NO  
CARCINOGENICITY - IARC: NO  
CARCINOGENICITY - OSHA: NO  
Explanation CARCINOGENICITY: NONE  
Signs/Symptoms Of Overexp: HEADACHE, DIZZINESS, FATIGUE, GARLIC BREATH, NAUSEA, VOMITING, ABDOMINAL PAIN, UNCONSCIOUSNESS, DEATH, CONVULSION; REDDENING, BURNING, CRACKING AND PEELING OF SKIN; SEVERE EYE PAIN AND BLURRED VISION  
Med Cond Aggravated By Exp: INDIVIDUALS WITH PRE-EXISTING DISEASES OF THE EYE, SKIN, RESPIRATORY TRACT, LIVER, KIDNEYS, CNS MAY HAVE INCREASED SUSCEPTIBILITY TO THE TOXICITY OF EXCESSIVE EXPOSURES. IMMEDIATELY FLUSH WITH WATER FOR 15 MINUTES. HOLD EYELIDS OPEN. WIPE OFF EXCESS FROM SKIN BEFORE WASHING. INHALED: REMOVE

TO FRESH AIR. PROVIDE CPR/OXYGEN IF NEEDED. ORAL: IF CONSCIOUS, INDUCE VOMITING IMMEDIATELY BY GIVING TWO GLASSES OF WATER AND STICKING FINGER DOWN THROAT. NEVER GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON.

---

#### Precautions for Safe Handling and Use

---

Steps If Matl Released/Spill: WEAR PROTECTIVE EQUIPMENT. VENTILATE AREA. REMOVE IGNITION SOURCES. KEEP OUT OF SEWER. ABSORB SMALL SPILL WITH PAPER TOWELS. EVAPORATE UNDER HOOD & BURN PAPER IN SUITABLE PLACE. USE SAND FOR LARGE SPILLS. TRANSFER TO PROPER CONTAINER FOR DISPOSAL.

Neutralizing Agent: NOT RELEVANT

Waste Disposal Method: ATOMIZE IN A RCRA APPROVED COMBUSTION CHAMBER OR DISPOSE OF AS HAZARDOUS WASTE IN A RCRA APPROVED FACILITY. DO NOT FLUSH TO SEWER. ENSURE COMPLIANCE WITH FEDERAL, STATE & LOCAL LAWS. REPORTABLE QTY (RQ) (CWA/CERCLA):5000LB

Precautions-Handling/Storing: STORE IN COOL, DRY, WELL-VENTILATED AREA, AWAY FROM IGNITION SOURCES & INCOMPATIBLE MATERIALS. OUTSIDE STORAGE PREFERRED.

Other Precautions: POISON AND FLAMMABLE. EMPTY CONTAINERS RETAIN RESIDUE AND CAN BE DANGEROUS. DO NOT CUT, WELD, SOLDER OR DRILL ON OR NEAR CONTAINER. AVOID BREATHING VAPORS. DO NOT GET IN EYES, SKIN OR CLOTHING. DO NOT SMOKE. KEEP OUT OF REACH OF CHILDREN.

---

#### Control Measures

---

Respiratory Protection: IF TLV IS EXCEEDED OR FOR SYMPTOMS OF OVER EXPOSURE, WEAR NIOSH-APPROVED SUPPLIED AIR-RESPIRATOR OR A NIOSH-APPROVED POSITIVE-PRESSURE SELF-CONTAINED BREATHING APPARATUS.

Ventilation: MECHANICAL (GENERAL AND/OR LOCAL EXHAUST, EXPLOSION-PROOF) VENTILATION TO MAINTAIN EXPOSURE BELOW TLV(S).

Protective Gloves: PVA

Eye Protection: GOGGLES AND/OR FULL FACE SHIELD

Other Protective Equipment: FULL PROTECTIVE CLOTHING, SAFETY SHOWER, EYE WASH STATION, BOOTS, LAB COAT. DO NOT WEAR CONTACT LENSES.

Work Hygienic Practices: OBSERVE GOOD INDUSTRIAL HYGIENE PRACTICES AND RECOMMENDED PROCEDURES. WASH THOROUGHLY BEFORE EATING, DRINKING/SMOKING.

---

#### Transportation Data

---

Trans Data Review Date: 95039

DOT PSN Code: CVR

DOT Proper Shipping Name: CARBON DISULFIDE

DOT Class: 3

DOT ID Number: UN1131

DOT Pack Group: I

DOT Label: FLAMMABLE LIQUID, POISON

IMO PSN Code: DOT

IMO Proper Shipping Name: CARBON DISULPHIDE

IMO Regulations Page Number: SEE 3109

IMO UN Number: 1131

IMO UN Class: 3.1

IMO Subsidiary Risk Label: TOXIC

IATA PSN Code: FIQ

IATA UN ID Number: 1131

IATA UN Class: 3

IATA Subsidiary Risk Class: 6.1

AFI PSN Code: ZZY



AFI Prop. Shipping Name: FORBIDDEN BY THIS MODE OF TRANSPORTATION

=====

Disposal Data

=====

Disposal Data Review Date: 88270

Rec # For This Disp Entry: 01

Tot Disp Entries Per NSN: 001

Landfill Ban Item: YES

Disposal Supplemental Data: MSDS FM MFR DATED 12 JULY 85 & CONFORMS TO OSHA HAZ COMM STD IN CASE OF ACCIDENTAL EXPOSURE OR DISCHARGE, CONSULT HEALTH AND SAFETY FILE FOR PRECAUTIONS.

1st EPA Haz West Code New: P022

1st EPA Haz West Name New: CARBON DISULFIDE; CARBON BISULFIDE

1st EPA Haz Wst Char New: ACUTELY TOXIC (H)

1st EPA Acute Hazard New: YES

2nd EPA Haz Wst Code New: D001

2nd EPA Haz Wst Name New: IGNITIBLE

2nd EPA Haz Wst Char New: IGNITABILITY

2nd EPA Acute Hazard New: NO

=====

Label Data

=====

Label Required: YES

Technical Review Date: 08FEB95

MFR Label Number: UNKNOWN

Label Status: F

Common Name: CARBON DISULFIDE,4351-030

Signal Word: DANGER!

Acute Health Hazard-Severe: X

Contact Hazard-Severe: X

Fire Hazard-Severe: X

Reactivity Hazard-None: X

Special Hazard Precautions: TARGET ORGANS: EYES, SKIN, CNS, LIVER, KIDNEYS, RESPIRATORY & GI TRACTS. ACUTE- TOXIC. MAY BE FATAL IF SWALLOWED/INHALED. HARMFUL IF ABSORBED THROUGH SKIN. EYE CONTACT MAY CAUSE SEVERE PAIN. INHALATION CAUSES CNS DEPRESSION. CHRONIC- LIVER, RENAL & REPRODUCTIVE DISORDERS. STORE IN COOL, WELL-VENTILATED AREA, AWAY FROM IGNITION SOURCES & INCOMPATIBLES. USE SAND TO REMOVE SPILL. FIRST AID- GET IMMEDIATE MEDICAL ATTENTION. EYE/SKIN: IMMEDIATELY FLUSH WITH WATER FOR 15 MINUTES. HOLD EYELIDS OPEN. INHALED: REMOVE TO FRESH AIR. PROVIDE CPR/OXYGEN IF NEEDED. ORAL: IF CONSCIOUS, INDUCE VOMITING BY GIVING TWO GLASSES OF WATER & STICKING FINGER DOWN THROAT.

Protect Eye: Y

Protect Skin: Y

Label Name: MALLINCKRODT INC.,SCIENCE PRODUCTS DIVISION

Label Street: PARIS BYPASS

Label P.O. Box: M

Label City: PARIS

Label State: KY

Label Zip Code: 40361

Label Country: US

Label Emergency Number: 314-982-5000

=====

T & R CHEMICALS — MURIATIC ACID - ACID

MATERIAL SAFETY DATA SHEET

FSC: 6810

NIIN: 00F032922

Manufacturer's CAGE: TRCHE

Part No. Indicator: A

Part Number/Trade Name: MURIATIC ACID

=====

General Information

=====

Item Name: ACID

Company's Name: T & R CHEMICALS, INC

Company's Street: 700 CELUM ROAD

Company's P. O. Box: 330

Company's City: CLINT

Company's State: TX

Company's Country: US

Company's Zip Code: 79836

Company's Emerg Ph #: 915-851-2761

Company's Info Ph #: 915-851-2761

Record No. For Safety Entry: 001

Tot Safety Entries This Stk#: 001

Status: SE

Date MSDS Prepared: 27JAN89

Safety Data Review Date: 14FEB94

Preparer's Company: T & R CHEMICALS, INC

Preparer's St Or P. O. Box: 700 CELUM ROAD

Preparer's City: CLINT

Preparer's State: TX

Preparer's Zip Code: 79836

MSDS Serial Number: BTBJB

=====

Ingredients/Identity Information

=====

Proprietary: NO

Ingredient: HYDROCHLORIC ACID, HYDROGEN CHLORIDE, MURIATIC ACID HYDROCHLORIDE

Ingredient Sequence Number: 01

Percent: 35.2

NIOSH (RTECS) Number: MW4025000

CAS Number: 7647-01-0

OSHA PEL: 5 PPM

ACGIH TLV: C 11 MG/CUM

Other Recommended Limit: 7 PPM

=====

Physical/Chemical Characteristics

=====

Appearance And Odor: CLEAR LIQUID, COLORLESS TO PALE YELLOW, PUNGENT, IRRITATING  
ACIDIC ODOR

Vapor Pressure (MM Hg/70 F): 30

Specific Gravity: 1.18

Solubility In Water: COMPLETE

=====

Fire and Explosion Hazard Data

=====

Flash Point: NONE

Special Fire Fighting Proc: WEAR SELF-CONTAINED BREATHING APPARATUS & FULL PROTECTIVE CLOTHING. USE WATER SPRAY TO COOL NEARBY CONTAINERS/ STRUCTURES EXPOSED TO FIRE.

Unusual Fire And Expl Hazrds: FLAMMABLE GAS (HYDROGEN) WILL BE LIBERATED FROM CONTACT W/SOME METALS.

=====

Reactivity Data

=====

Stability: YES

Materials To Avoid: ALKALIS/OXIDIZING OR REDUCING MATERIALS/CYANIDES/ SULFIDES/COMBUSTIBLE MATERIALS/METALS/METAL OXIDES/AMINES/VINYL ACETATE

Hazardous Decomp Products: HYDROGEN & CHLORINE UNDER CERTAIN OXIDIZING OR REDUCING CONDITIONS

Hazardous Poly Occur: NO

=====

Health Hazard Data

=====

Route Of Entry - Inhalation: YES

Route Of Entry - Skin: YES

Route Of Entry - Ingestion: YES

Health Haz Acute And Chronic: INHALATION: VAPORS/MISTS ARE EXTREMELY CORROSIVE TO NOSE, THROAT & MUCOUS MEMBRANES; MAY BE FATAL. EYES: EXTREMELY CORROSIVE. SKIN: SEVERE BURNS, DERMATITIS; FATAL W/DEATH IF LARGE AREAS EFFECTED, DESTROY SURROUNDING TISSUE. INGESTION: EXTREMELY CORROSIVE TO MOUTH & THROAT W/BURNS, SEVERE ABDOMINAL PAIN; MAY BE FATAL.

CARCINOGENICITY - NTP: NO

CARCINOGENICITY - IARC: NO

CARCINOGENICITY - OSHA: NO

Explanation CARCINOGENICITY: NONE

Signs/Symptoms Of Overexp: INHALATION: IRRITATION, COUGHING, CHEST PAIN, BREATHING DIFFICULTY. INGESTION: VOMITING, NAUSEA, COLLAPSE; MAY CAUSE DEATH.

Med Cond Aggravated By Exp: RESPIRATORY ILLNESS W/ATTENDANT TISSUE DAMAGE & DESTRUCTION

Emergency/First Aid Proc: EYES: FLUSH W/PLENTY OF WATER FOR AT LEAST 30 MINS. SKIN: FLUSH W/PLENTY OF WATER. INHALATION: REMOVE TO FRESH. IF BREATHING STOPS, GIVE ARTIFICIAL RESPIRATION. INGESTION: DON'T INDUCE VOMITING. IF CONSCIOUS, GIVE PLENTY OF WATER. IF UNCONSCIOUS, DON'T GIVE ANYTHING BY MOUTH. OBTAIN MEDICAL ATTENTION IN ALL CASES.

=====

Precautions for Safe Handling and Use

=====

Steps If Matl Released/Spill: WEAR ACID-RESISTANT PROTECTIVE CLOTHING & SCBA. NEUTRALIZE. SMALL: EFFECTIVE MOP-UPS W/DISPOSAL OF WASTES IN DOT APPROVED WASTE CONTAINERS AFTER LIME OR SODA ASH NEUTRALIZATIONS HAVE BEEN MADE ARE ACCEPTABLE.

Neutralizing Agent: LIME OR SODA ASH

Waste Disposal Method: DISPOSE OF WASTE IN ACCORDANCE W/FEDERAL, STATE & LOCAL REGULATIONS.

Precautions-Handling/Storing: STORE IN COOL, DRY, WELL-VENTILATED PLACE.

KEEP CONTAINERS TIGHTLY CLOSED WHEN NOT IN USE & CHECK PERIODICALLY FOR ANY ESCAPED MATERIAL.

Other Precautions: DON'T APPLY PRESSURE TO REMOVE CONTENTS FROM ANY CONTAINER.

DON'T CUT, GRIND, WELD OR DRILL ON OR NEAR CONTAINERS OF ACIDS. EMPLOY STANDARD SAFETY PRACTICES APPLIED WHEN AROUND ACIDIC MATERIALS.

Control Measures

Respiratory Protection: NIOSH APPROVED RESPIRATOR FOR VAPOR/MIST CONCENTRATION AT POINT OF USE; FULL FACEPIECE OR HALF MASK AIR-PURIFYING CARTRIDGE RESPIRATOR EQUIPPED FOR ACID GASES/MISTS, SCBA IN PRESSURE DEMAND MODE, OR SUPPLIED-AIR RESPIRATORS

Ventilation: REQUIRED

Protective Gloves: ACID-RESISTANT RUBBER

Eye Protection: CHEMICAL GOGGLES & FULL FACE SHIELD

Other Protective Equipment: ACID-RESISTANT RUBBER SLICKER SUIT W/RUBBER APRON BOOTS W/PANTS OUTSIDE & RUBBER GLOVES W/GAUNTLETS

Work Hygienic Practices: REMOVE/LAUNDER CONTAMINATED CLOTHING/SHOES BEFORE REUSE. WASH THOROUGHLY AFTER HANDLING.

Transportation Data

Disposal Data

Label Data

Label Required: YES

Technical Review Date: 14FEB94

Label Date: 10FEB94

Label Status: F

Common Name: MURIATIC ACID

Chronic Hazard: YES

Signal Word: DANGER!

Acute Health Hazard-Severe: X

Contact Hazard-Severe: X

Fire Hazard-None: X

Reactivity Hazard-Slight: X

Special Hazard Precautions: INHALATION: VAPORS/MISTS ARE EXTREMELY CORROSIVE TO NOSE, THROAT & MUCOUS MEMBRANES; MAY BE FATAL. EYES: EXTREMELY CORROSIVE. SKIN: SEVERE BURNS, DERMATITIS; FATAL W/DEATH IF LARGE AREAS EFFECTED, DESTROY SURROUNDING TISSUE. INGESTION: EXTREMELY CORROSIVE TO RESPIRATORY & DIGESTIVE TRACTS, EYES, SKIN.

Protect Eye: Y

Protect Skin: Y

Protect Respiratory: Y

Label Name: T & R CHEMICALS, INC

Label Street: 700 CELUM ROAD

Label P.O. Box: 330

Label City: CLINT

Label State: TX

Label Zip Code: 79836

Label Country: US

Label Emergency Number: 915-851-2761

Year Procured: UNK